

TITLE OF THE INVENTION
EXPOSURE APPARATUS

FIELD OF THE INVENTION

5 The present invention relates to an exposure apparatus which transfers a pattern onto a substrate using an exposure beam.

BACKGROUND OF THE INVENTION

10 A manufacturing process for a semiconductor element such as an LSI or VLSI formed from a micropattern uses a reduction type projection exposure apparatus for transferring by reduction projection a circuit pattern drawn on a mask onto a substrate coated
15 with a photosensitive agent. With an increase in the packaging density of semiconductor elements, demands have arisen for further micropatterning. Exposure apparatuses are coping with micropatterning along with the development of a resist process.

20 A means for increasing the resolving power of the exposure apparatus includes a method of changing the exposure wavelength to a shorter one, and a method of increasing the numerical aperture (NA) of the projection optical system.

25 As for the exposure wavelength, the 365-nm i-line has been replaced by a KrF excimer laser with an oscillation wavelength of around 248 nm. Also, an ArF

excimer laser with an oscillation wavelength around 193 nm and a fluorine (F_2) excimer laser with an oscillation wavelength around 157 nm have been developed.

5 An ArF excimer laser with a wavelength around far ultraviolet rays, particularly, 193 nm, and a fluorine (F_2) excimer laser with an oscillation wavelength around 157 nm are known to have a plurality of oxygen (O_2) absorption bands around their wavelength bands.

10 For example, a fluorine excimer laser has been applied to an exposure apparatus because of a short wavelength of 157 nm. The 157-nm wavelength falls within a wavelength region generally called a vacuum ultraviolet region. In this wavelength region, light
15 is greatly absorbed by oxygen molecules, and hardly passes through air. Thus, the fluorine excimer laser can only be applied in an environment in which the atmospheric pressure is decreased to almost vacuum and the oxygen concentration is fully decreased.

20 According to a reference "Photochemistry of Small Molecules" (Hideo Okabe, A Wiley-Interscience Publication, 1978, p. 178), the absorption coefficient of oxygen to 157-nm light is about $190 \text{ atm}^{-1}\text{cm}^{-1}$. This means that, when 157-nm light passes through gas at an
25 oxygen concentration of 1% at one atmospheric pressure, the transmittance per cm is only

$$T = \exp(-190 \times 1 \text{ cm} \times 0.01 \text{ atm}) = 0.150$$

Oxygen absorbs light to generate ozone (O_3), and ozone promotes absorption of light, greatly decreasing the transmittance. In addition, various products generated by ozone are deposited on the surface of an optical element, decreasing the efficiency of the optical system.

To prevent this, the oxygen concentration in the optical path is suppressed to low level of several ppm order or less by a purge mechanism using inert gas such as nitrogen in the optical path of the exposure optical system of a projection exposure apparatus using a far ultraviolet laser such as an ArF excimer laser or fluorine (F_2) excimer laser as a light source.

In such an exposure apparatus using an ArF excimer laser beam with a wavelength around far ultraviolet rays, particularly, 193 nm, or a fluorine (F_2) excimer laser beam with a wavelength around 157 nm, an ArF excimer laser beam or fluorine (F_2) excimer laser beam is readily absorbed by a substance. The optical path must be purged to several ppm order or less. This also applies to moisture, which must be removed to ppm order or less.

To ensure the transmittance or stability of ultraviolet rays, the ultraviolet path of the reticle stage or the like of an exposure apparatus or the like is purged with inert gas. For example, Japanese Patent Laid-Open No. 6-260385 discloses a method of spraying

inert gas toward a photosensitive substrate. However, oxygen and moisture cannot be satisfactorily purged. Japanese Patent Laid-Open No. 8-279458 discloses a method of covering the whole space near a
5 photosensitive substrate with a sealing member from the lower end of a projection optical system. However, this method is not practical because it is difficult to move the stage.

As described above, an exposure apparatus using
10 ultraviolet rays, particularly, an ArF excimer laser beam or fluorine (F_2) excimer laser beam suffers large absorption by oxygen and moisture at the wavelength of the ArF excimer laser beam or fluorine (F_2) excimer laser beam. To obtain a sufficient transmittance and
15 stability of ultraviolet rays, the oxygen and moisture concentrations must be reduced.

From this, it is desired to develop an effective means for purging the ultraviolet path in an exposure apparatus, particularly, the vicinities of a wafer and
20 reticle with inert gas.

However, vibration sources such as the motors and air compressors of various units installed on the floor and units to be isolated from vibrations, such as a projection optical system, an alignment system, a laser
25 interferometer, and a stage, supported by a vibration isolating mechanism coexist in an exposure apparatus. For this reason, if a space between the vibration

sources and the units is purged with inert gas,
vibrations are transmitted through a connecting member
arranged between them to sustain airtightness.
Consequently, the units supported by the vibration
5 isolating mechanism vibrate, thereby causing a
reduction in exposure precision and the like.

Assume that a bellows structural member is
employed as the connecting member to sustain
airtightness. In this case, the bellows structure
10 member has flexibility in the compression direction and
high rigidity in the shear and twist directions, but
vibrations cannot be satisfactorily isolated.

SUMMARY OF THE INVENTION

15 The present invention has been made in
consideration of the above-mentioned background, and
has as its object to, e.g., suppress transmission of
vibration between two independently supported
structures through a member for connecting the
20 structures and forming an enclosed space.

According to the present invention, there is
provided an exposure apparatus which transfers a
pattern onto a substrate with exposure light,
characterized by comprising a partition wall which
25 encloses a path of exposure light and isolates the path
from surroundings, and a connecting member in a tubular
form which connects the partition wall and a structure

supported independently of the partition wall and sustains airtightness in a space enclosed with the partition wall, wherein a section of the connecting member, taken in a direction perpendicular to an axis
5 of the connecting member, has a three-dimensional portion. Use of a connecting member with this structure suppresses transmission of vibrations between a room (closed space) comprising a partition wall and a structure supported independently of the partition
10 wall, thereby avoiding disadvantages caused by transmission of vibrations, e.g., any decrease in exposure precision.

According to a preferred embodiment of the present invention, the section of the connecting member
15 preferably has a plurality of three-dimensional portions.

According to a preferred embodiment of the present invention, the connecting member preferably connects the structure and the partition wall in an
20 axially compressed state.

According to a preferred embodiment of the present invention, the connecting member is preferably made of resin, rubber (e.g., fluororubber) or the like.

According to a preferred embodiment of the present invention, the connecting member is preferably
25 made of a material having a thickness of not more than 2 mm. Alternatively, the connecting member is

preferably arranged to be resistant to a gage pressure of not more than 1 MPa.

In the present invention, the term "tubular form" includes a structure which has a polygonal (e.g.,
5 quadrangular) section with a three-dimensional portion and a structure which has a circular section with a three-dimensional portion.

According to a preferred embodiment of the present invention, preferably, the structure is
10 supported by a vibration isolating mechanism, and the partition wall is preferably supported by a structure which can transmit vibrations to the partition wall. The partition wall can be supported by a support member which receives vibrations from a floor. The partition
15 wall may connect to a second structure other than the structure through a second connecting member, and in this case, the second connecting member preferably has the same structure as a structure of the connecting member.

20 Alternatively, the structure is supported by a structure which can transmit vibrations to the structure, and the partition wall may be supported through a vibration isolating mechanism.

According to a preferred embodiment of the
25 present invention, a substrate stage or reticle stage can be arranged in the space enclosed with the partition wall.

According to the present invention, there is provided a device manufacturing method comprising a step of transferring a pattern onto a substrate using the above-mentioned exposure apparatus, and a step of
5 developing the substrate.

Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which like reference characters designate
10 the same or similar parts throughout the figures thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated
15 in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

Fig. 1 is a perspective view showing the
20 structure of an airtightness sustaining mechanism according to a preferred embodiment of the present invention;

Fig. 2 is a view of a model of an airtightness sustaining mechanism shown in Fig. 1;

25 Fig. 3 is a graph showing the flexibility of the model shown in Fig. 2, which depends on the shape of a three-dimensional portion;

Fig. 4 is a view showing the schematic arrangement of an exposure apparatus according to the preferred embodiment of the present invention;

Fig. 5 is a perspective view of a partition wall (purge chamber) portion in Fig. 4;

Fig. 6 is a sectional view of a connecting member of the airtightness sustaining mechanism, taken in a direction perpendicular to the axial direction;

Fig. 7 is a view showing another structure of the connecting member;

Fig. 8 is a view showing still another structure of the connecting member;

Fig. 9 is a view showing still another structure of the connecting member;

Fig. 10 is a view of a model of an airtightness sustaining mechanism with a bellows structure;

Fig. 11 is a view of a model of an airtightness sustaining mechanism according to the present invention;

Fig. 12 is a view showing the flexibility of the airtightness sustaining mechanism with the bellows structure;

Fig. 13 is a view showing the flexibility of the airtightness sustaining mechanism according to the present invention;

Fig. 14 is a flow chart showing the flow of the whole manufacturing process of a semiconductor device;

and

Fig. 15 is a flow chart showing the detailed flow of the wafer process.

5 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

First, the principle of the present invention will be described.

Fig. 10 is a view of a model of a conventional airtightness sustaining mechanism with a bellows structure. The modeled structure has a hollow connecting member 130 between a first portion (flange) 110 and a second portion (flange) 120. A distance between the first portion 110 and the second portion 120 in an uncompressed state is represented by T1. If the structure is vertically compressed such that the distance T1 reduces to a distance T2, the connecting member 130 transforms into a bellows structure portion 130'.

Fig. 11 is a view of a model of an airtightness sustaining mechanism according to the present invention. The modeled structure has a tubular or hollow connecting member 230 between a first portion (flange) 210 and a second portion (flange) 220. In this structure, the connecting member 230 has a three-dimensional portion 231 comprised of axially (in the Z direction in Fig. 11) extending projections and recesses. Use of the structure so compressed as to

reduce a thickness $T1$ of the connecting member can provide an airtightness sustaining mechanism with high flexibility in the shear direction (X direction in Fig. 11).

5 It will be described with reference to Figs. 12 and 13 that the airtightness sustaining mechanism of the present invention is more excellent in flexibility in the shear direction than the conventional airtightness sustaining mechanism.

10 Fig. 12 shows the first portion (flange) 110 and second portion (flange) 120 of the conventional airtightness sustaining mechanism with the bellows structure. Assume that a length $L2$, in the diagonal direction, of a surface 131 of a connecting member (not
15 shown) interposed between the first portion 110 and the second portion 120 does not change. If a distance between the first portion 110 and the second portion 120 reduces from $T1$ to $T2$, the first portion 110 and the second portion 120 have a relative shift $S2$ in the
20 shear direction (X direction in Fig. 13).

 Fig. 13 shows the first portion (flange) 210 and second portion (flange) 220 of the airtightness sustaining mechanism of the present invention. Assume that a length $L1$, in the diagonal direction, of the
25 surface 231 of a connecting member (not shown) interposed between the first portion 210 and the second portion 220 does not change. If a distance between the

first portion 210 and the second portion 220 reduces from T1 to T2, the first portion 210 and the second portion 220 have a relative shift S1 in the shear direction (X direction in Fig. 13).

5 As can be seen from Figs. 12 and 13, the shift amount S1, in the shear direction, of the airtightness sustaining mechanism of the present invention is larger than the shift amount S2, in the shear direction, of the conventional airtightness sustaining mechanism.

10 That is, the airtightness sustaining mechanism of the present invention is more flexible than the conventional airtightness sustaining mechanism and can increase a shift amount between the first member and the second member.

15 The airtightness sustaining mechanism of the present invention can be applied to various apparatuses including an exposure apparatus. The airtightness sustaining mechanism of the present invention is particularly suitable for an exposure apparatus using
20 far ultraviolet rays such as an ArF excimer laser with a wavelength around 193 nm and a fluorine (F₂) excimer laser with a wavelength around 157 nm.

 An airtightness sustaining mechanism according to a preferred embodiment of the present invention will be
25 described next. Fig. 1 is a perspective view showing the structure of the airtightness sustaining mechanism according to the preferred embodiment of the present

invention. The airtightness sustaining mechanism is suitable for an exposure apparatus for manufacturing devices such as a semiconductor device.

An airtightness sustaining mechanism 50 according to the preferred embodiment of the present invention causes the first structure and the second structure to communicate with each other and isolates them from the external space (i.e., sustains airtightness), thereby forming an enclosed space. At least one of the first and second structures comprises a structure which forms a space.

The airtightness sustaining mechanism 50 comprises a first flange 38a to be connected to the first structure, a second flange 38b to be connected to the second structure, and a tubular or hollow connecting member 37 which connects the first flange 38a and second flange 38b. A "tubular" structure may be any structure with a closed-figure section such as a polygonal section as well as a circular section.

The airtightness sustaining mechanism 50 is typically interposed between the first structure and the second structure in an axially compressed state.

The connecting member 37 has one or more three-dimensional portions 37a in a section taken in a direction (along a plane parallel to the X-Y plane in Fig. 1) perpendicular to the axial direction (Z direction in Fig. 1), i.e., a direction in which the

first and second flanges 38a and 38b face each other, as shown in Fig. 6. The three-dimensional portion 37a comprises a projection and a recess which axially extend. The three-dimensional portion 37a is
5 preferably provided on each side of the connecting member 37. More preferably, each side of the connecting member has a plurality of three-dimensional portions 37a.

By providing one or more three-dimensional
10 portions 37a in the connecting member 37, the airtightness sustaining mechanism 50 can increase the flexibility in the shear (X and Y directions in Fig. 1), compression (Z direction in Fig. 1), and rotation (directions about the X-, Y-, and Z-axes,
15 particularly, the direction about the Z-axis) directions. With this structure, even if the connecting member 37 is made of a material with small elasticity such as a rubber sheet combined with a fabric, the airtightness sustaining mechanism 50 can
20 obtain high flexibility in all of the compression, shear, and rotation directions.

The connecting member 37 is preferably made of resin, rubber (e.g., fluororubber), or the like. A wall member constituting the connecting member 37
25 preferably has a thickness of 2 mm or less. The connecting member 37 is preferably arranged to be resistant to a gage pressure of 1 MPa or less. The

above-mentioned arrangement contributes to an increase in flexibility of the connecting member 37.

As an example, the flexibility in the shear direction will be described below. For the sake of descriptive simplicity, Fig. 2 shows a model of the airtightness sustaining mechanism shown in Fig. 1. A first member (flange) 41, a second member (flange) 42, and a connecting member 43 in Fig. 2 correspond to the first flange 38a, second flange 38b, and connecting member 37 in Fig. 1, respectively. The model of Fig. 2 has a three-dimensional portion including a projection 43a on a side of the connecting member 37. Although Fig. 2 shows only one projection 43a, a plurality of projections 43a may be provided at intervals A.

A maximum shift amount dA which indicates the flexibility, in the shear direction, of the airtightness sustaining mechanism shown in Fig. 2 can be represented by equation (1):

$$dA = (A^2 + 2dH \cdot H - dH^2)^{1/2} - A \quad \dots(1)$$

where A is a distance between the projections 43a of the connecting member 43 (distance between steps), H is a length, in the axial direction (Z direction), of the connecting member 43, and dH is a compression amount in the axial direction.

Fig. 3 shows the maximum shift amount dA when the length $H = 60$ mm and the compression amount $dH = 50$ mm are substituted into equation (1). The maximum shift

amount dA depends on the distance A .

As shown in Fig. 3, by increasing the number of three-dimensional portions and decreasing the distance A between the projections 43a, the maximum shift amount
5 can be increased, thereby obtaining a structure with high flexibility.

Fig. 4 is a schematic view showing an example of an exposure apparatus having the airtightness sustaining mechanism shown in Fig. 1. The exposure
10 apparatus main body is stored in a chamber 1, and the ambient temperature of the exposure apparatus main body is so controlled as to have a precision of, e.g., about $\pm 0.03^\circ\text{C}$.

The exposure apparatus shown in Fig. 4 comprises
15 a base frame 2 serving as the base of the exposure apparatus main body, a reticle stage 3 which can move while holding a reticle (master), a wafer stage 4 which can move while holding a wafer (substrate), an illumination optical system 5 which illuminates a
20 reticle with illumination light, a projection optical system 6 which reduces and projects a reticle pattern onto a wafer at a predetermined magnification (e.g., 4 : 1), a lens barrel surface plate 7 which holds the projection optical system 6, and an air-conditioned
25 equipment room 8 which supplies temperature-controlled clean air.

The projection optical system 6 is a single

barrel type catadioptric system, similar to a projection optical system disclosed in Japanese Patent Laid-Open No. 2001-27727. The projection optical system 6 has a closed structure, and its interior is
5 purged with temperature/humidity-controlled inert gas such as nitrogen or helium.

The illumination optical system 5 introduces illumination light through a beam line extending from a light source device 46 which is set on the floor
10 separately from the exposure apparatus or an internal light source device. The illumination optical system 5 generates slit light from the introduced illumination light through various lenses and stops, and slit-illuminates a reticle held by the reticle stage 3
15 from above the reticle. Examples of illumination light are an excimer laser beam (e.g., KrF, ArF, or F₂), harmonic (e.g., YAG laser beam or metal vapor laser beam), and ultraviolet rays (e.g., i-line). The illumination optical system 5 has a closed or almost
20 closed structure, and its interior is purged with temperature/humidity-controlled inert gas such as nitrogen or helium.

The base frame 2 is set on the installation floor of the clean room of a semiconductor manufacturing
25 factory. The base frame 2 is fixed to the floor at high rigidity, and can be regarded to be substantially integrated with the floor or extend from the floor.

The base frame 2 includes three or four high-rigidity columns, and vertically supports the lens barrel surface plate 7 through active dampers (vibration isolating mechanisms) 9 at the tops of the columns.

5 The active damper 9 incorporates an air spring, damper, and actuator. The active damper 9 prevents transmission of high-frequency vibrations from the floor to the lens barrel surface plate 7, and actively compensates for the tilt or swing of the lens barrel
10 surface plate 7.

The lens barrel surface plate 7 which holds the projection optical system 6 also supports a reticle stage surface plate 10 through a reticle holding frame 34. The lens barrel surface plate 7 is equipped with
15 an alignment detector for detecting the alignment states of a reticle and wafer. Alignment is performed using the lens barrel surface plate 7 as a reference.

A wafer is set on the wafer stage 4. The position of the wafer stage 4 is measured by an
20 interferometer (not shown), and the wafer stage 4 can be driven in an optical axis direction (Z direction) of the projection optical system 6, X and Y directions perpendicular to the optical axis direction, and ω_x , ω_y , and ω_z directions around the axes.

25 A linear motor is adopted as an alignment driving source. The wafer stage 4 basically comprises a two-dimensional stage constituted by an X stage which

moves straight in the X direction, an X linear motor, a Y stage which moves straight in the Y direction perpendicular to the X direction, and a Y linear motor. A stage capable of moving in the Z direction, tilt (ωX and ωY) directions, and rotational (ωZ) direction is mounted on the two-dimensional stage.

The wafer stage 4 is supported by a wafer stage surface plate 11, and moves on the X-Y horizontal guide surface (guide surface) of the wafer stage surface plate 11. The wafer stage surface plate 11 is supported on a stage base member 12 by three (or four) support legs.

The stage base member 12 is vertically supported by the base frame 2 at three portions through three active dampers (vibration isolating mechanisms) 13. Most of the load of the stage base member 12 and members mounted on it is basically supported by the three active dampers 13. The load received by the active dampers 13 is received by the base frame 2 which is substantially integrated with the floor. Thus, the basic load of the wafer stage 4 is substantially supported by the floor. The active damper 13 uses an air spring capable of supporting a large load.

The position of the reticle stage 3 is also measured by an interferometer (not shown), and the reticle stage 3 can be driven in the X and Y directions perpendicular to the optical axis direction (Z

direction) of the projection optical system 6.

By illumination of the illumination system 5, the pattern image of a reticle is projected onto a wafer held by the wafer stage 4 through the projection optical system 6. At this time, the wafer stage 4 and reticle stage 3 are relatively moved in a direction perpendicular to the optical axis direction (Z direction) of the projection optical system 6. As a result, the pattern image is transferred in a predetermined region on the wafer. The same transfer operation is repeated by step & scan for a plurality of exposure regions on the wafer, thereby transferring the pattern on the entire surface of the wafer.

The reticle is stored in a reticle storage 15 and transferred by a reticle transfer system 16. The reticle storage 15 and reticle transfer system 16 are arranged in a space 17 within the chamber 1. The reticle is transferred by the reticle transfer system 16 to a reticle alignment unit 35. The reticle alignment unit 35 is fixed to the upper surface of the reticle holding frame 34, mounts/recovers the reticle on/from the reticle stage 3, and aligns the position of the reticle.

The wafer is stored in a wafer storage 20 and transferred by a wafer transfer system 21. The wafer storage 20 and wafer transfer system 21 are arranged in a space 18 within the chamber 1. The wafer is

mounted/recovered on/from the wafer stage 4 by the wafer transfer system 21.

An airtightness sustaining mechanism mounted near the wafer stage 4 of the exposure apparatus will be described next. As shown in Fig. 4, a box-like partition wall (purge chamber) 23 is interposed between the lens barrel surface plate 7 and the wafer stage 4. Fig. 5 is a perspective view of the partition wall 23 and its surroundings in Fig. 4. The partition wall 23 is supported through a support member 24 by the base frame 2. The partition wall 23 has openings in the upper and lower surfaces. The upper opening and the facing lower surface of the lens barrel surface plate (an example of a structure) 7 are connected by an airtightness sustaining mechanism 25 so as to sustain airtightness.

The lower opening of the partition wall 23 and the facing upper surface of the stage base member (an example of a structure) 12 which supports the wafer stage 4 are also connected by an airtightness sustaining mechanism 26 so as to sustain airtightness.

Each of the airtightness sustaining mechanisms 25 and 26 has a structure shown in Fig. 1 and is very flexible. The airtightness sustaining mechanisms 25 and 26 can thus keep the interior of the partition wall 23 airtight without transmitting vibrations of the box-like partition wall 23 which swings by vibrations

from the exposure apparatus installation floor, to the lens barrel surface plate 7 and wafer stage 4 which are supported by the active dampers 9 and active dampers 13.

5 The box-like partition wall 23 also has an opening on a side on which the wafer transfer system 21 is arranged. This opening and an opening formed in a chamber (an example of the second structure) 22 which covers the wafer transfer system 21 are also connected
10 by an airtightness sustaining mechanism 27a having the structure shown in Fig. 1 so as to sustain airtightness.

 The box-like partition wall 23 also has an opening on a side of a filter 29 connected to the
15 air-conditioned equipment room 8 through an air duct. This opening and the filter (an example of the second structure) 29 are also connected by an airtightness sustaining mechanism 27b having the structure shown in Fig. 1 so as to sustain airtightness.

20 Temperature-controlled inert gas such as nitrogen is supplied to a space (purge space) enclosed with the partition wall 23 near the wafer stage 4 through the filter 29. Gas supplied to the purge space passes through the space 18 and returns to the air-conditioned
25 equipment room 8 again through a return portion 30. More specifically, a circulation system of inert gas through the active damper 9, purge space, space 18, and

return portion 30 is constituted.

An airtightness sustaining mechanism mounted near the reticle stage 3 will be described next. As shown in Fig. 4, a box-like partition wall (purge chamber) 32 is arranged to cover the reticle stage 3. The partition wall 32 is supported by the reticle holding frame 34.

The box-like partition wall 32 has an opening on a side on which the reticle transfer system 16 as well as the optical path is arranged. This opening and an opening formed in a chamber 36 which airtightly covers the reticle transfer system 16 are also connected by an airtightness sustaining mechanism 28a having the structure shown in Fig. 1 so as to sustain airtightness.

The box-like partition wall 32 also has an opening on a side of a filter 33 connected to the air-conditioned equipment room 8 through an air duct. This opening and the filter 33 are also connected by an airtightness sustaining mechanism 28b having the structure shown in Fig. 1 so as to sustain airtightness.

Each of the airtightness sustaining mechanisms 28a and 28b has a structure shown in Fig. 1 and is very flexible. The airtightness sustaining mechanisms 28a and 28b can thus keep the interior of the partition wall 32 airtight without transmitting vibrations of the

chamber 36 of the reticle transfer system 16 which swings by vibrations from the exposure apparatus installation floor and vibrations of the air-conditioned equipment room 8, to the lens barrel surface plate 7 and reticle stage 3 which are supported by the active dampers 9.

Temperature-controlled inert gas such as nitrogen is supplied to a space (purge space) enclosed with the partition wall 32 near the reticle stage 3 through the filter 33.

With this arrangement, the optical path that extends from the illumination optical system 5 to the projection optical system 6 through a reticle and the optical path that extends from the projection optical system 6 to a wafer are purged with inert gas such as nitrogen having high transmittance even for far ultraviolet rays such as an ArF excimer laser beam or fluorine (F_2) excimer laser beam. Since illumination light reaches the wafer surface at high transmittance, the exposure time can be shortened to increase the throughput of the exposure process.

The lens barrel surface plate 7 and wafer stage 4 which are supported by the active dampers 9 and active dampers 13, respectively, are connected to the purge chamber constituted by the partition wall 23 through the flexible airtightness sustaining mechanisms 25 and 26, and transmission of vibrations from the purge

chamber is suppressed. In addition, the purge chamber is connected to the chamber 22 of the wafer transfer system 21 and air-conditioned equipment room 8 through the flexible airtightness sustaining mechanisms 27a and 27b, and transmission of vibrations from the chamber 22 and air-conditioned equipment room 8 to the purge chamber is suppressed.

The lens barrel surface plate 7 and reticle stage 3 which are supported by the active dampers 9 are connected to the chamber 36 of the reticle transfer system 16 and air-conditioned equipment room 8 through the flexible airtightness sustaining mechanisms 28a and 28b, and transmission of vibrations from the chamber 36 and air-conditioned equipment room 8 to the purge chamber is suppressed.

A sectional shape of the connecting member 37 shown in Fig. 1 can be changed to, e.g., any one of the shapes shown in Figs. 7 to 9. Each of Figs. 7 and 8, and Fig. 6 described above shows an example in which a section taken in a direction perpendicular to the axial direction has a certain polygonal shape with a three-dimensional portion, and the three-dimensional portions in Figs. 6 to 8 have different shapes. Fig. 9 shows an example in which a section taken in a direction perpendicular to the axial direction has a circular shape with a three-dimensional portion.

A semiconductor device manufacturing process

using the above-described exposure apparatus will be explained. Fig. 14 is a flow chart showing the flow of the whole manufacturing process of a semiconductor device. In step 1 (circuit design), the circuit of a semiconductor device is designed. In step 2 (mask formation), a mask is formed on the basis of the designed circuit pattern. In step 3 (wafer formation), a wafer is formed using a material such as silicon. In step 4 (wafer process) called a pre-process, an actual circuit is formed on the wafer by lithography using the mask and wafer. Step 5 (assembly) called a post-process is the step of forming a semiconductor chip by using the wafer formed in step 4, and includes an assembly process (dicing and bonding) and packaging process (chip encapsulation). In step 6 (inspection), the semiconductor device manufactured in step 5 undergoes inspections such as an operation confirmation test and durability test. After these steps, the semiconductor device is completed and shipped in step 7.

Fig. 15 is a flow chart showing the detailed flow of the wafer process. In step 11 (oxidation), the wafer surface is oxidized. In step 12 (CVD), an insulating film is formed on the wafer surface. In step 13 (electrode formation), an electrode is formed on the wafer by vapor deposition. In step 14 (ion implantation), ions are implanted in the wafer. In

step 15 (resist processing), a photosensitive agent is applied to the wafer. In step 16 (exposure), the above-mentioned exposure apparatus transfers a circuit pattern onto the wafer. In step 17 (developing), the
5 exposed wafer is developed. In step 18 (etching), the resist is etched except the developed resist image. In step 19 (resist removal), an unnecessary resist after etching is removed. These steps are repeated to form multiple circuit patterns on the wafer.

10 According to the present invention, for example, vibration transmission between two independently supported structures through a member for connecting the structures and forming an enclosed space can be suppressed. This can increase the exposure precision
15 in an exposure apparatus.

 As many apparently widely different embodiments of the present invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the
20 specific embodiments thereof except as defined in the appended claims.